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Quaderer

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(54) **PRINTED CIRCUIT BOARD WITH RECESSED REGION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(51) **Int. Cl.**
G02B 6/00 (2006.01)

(52) **U.S. Cl.** **385/147**; 385/14

(58) **Field of Classification Search** 385/14, 385/147

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0265671 A1* 12/2005 Ono et al. 385/92

OTHER PUBLICATIONS

2 pages that illustrate Bookham Pluggables sold by Bookham. The Applicant admits that this is prior art. As illustrated herein, the Bookham Pluggables include a ROSA, a flex cable, and a printed circuit board. The flex cable includes a plurality of tubular barrels that are soldered to ROSA pads on the ROSA. The ROSA/flex cable assembly is next soldered to the printed circuit board, Jul. 7, 2008.

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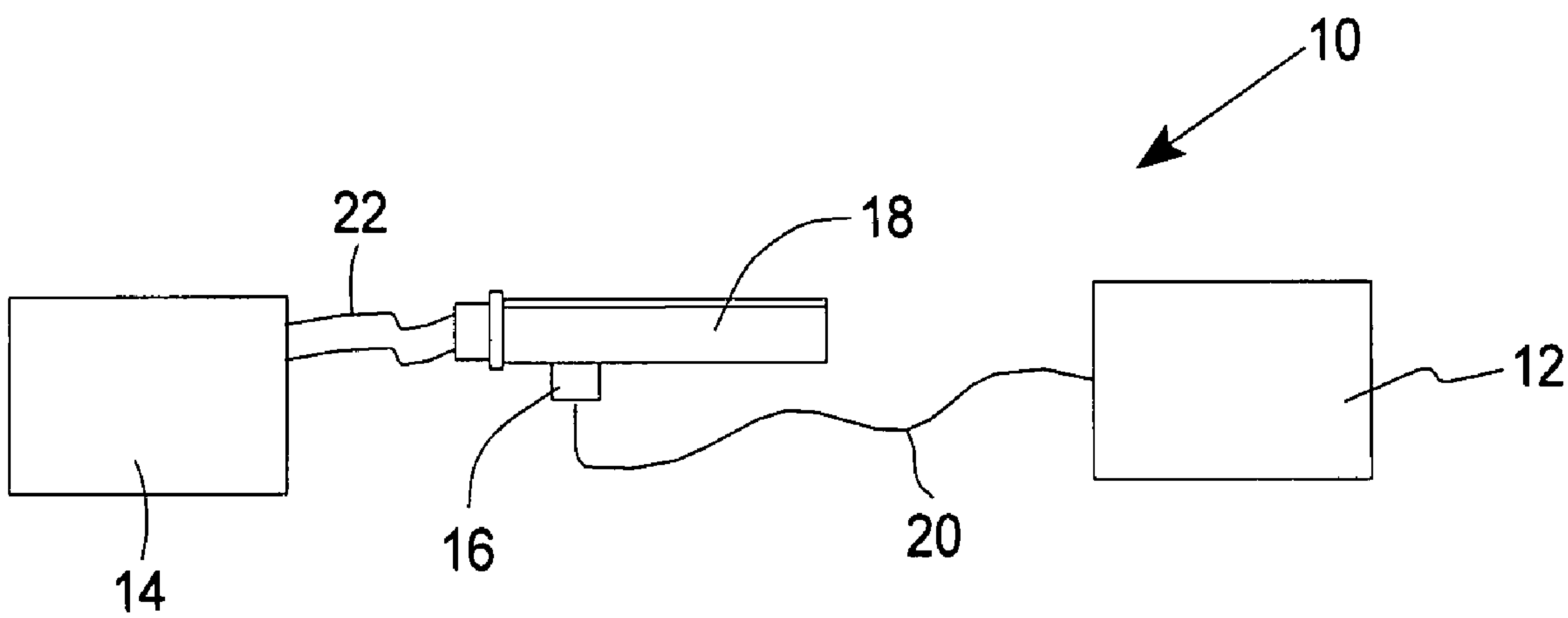
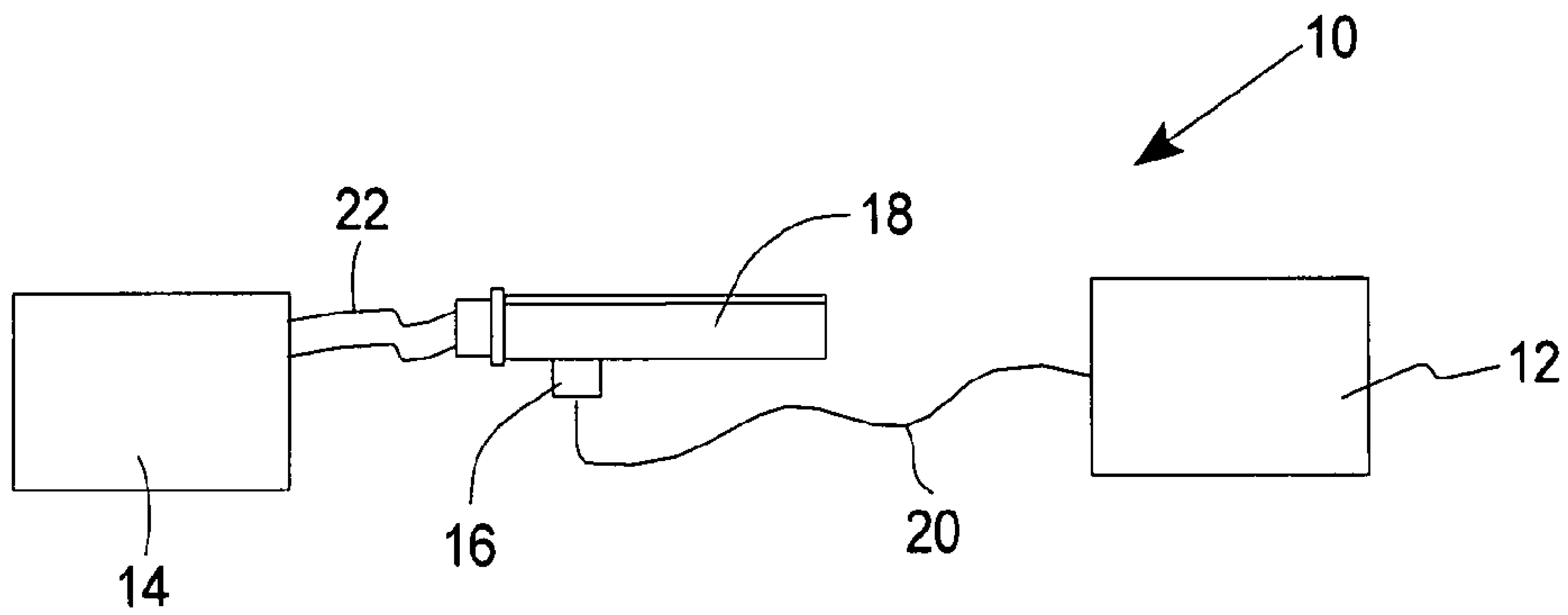
(74) *Attorney, Agent, or Firm*—Roeder & Broder LLP

(57) **ABSTRACT**

A printed circuit board (**18**) for electrically connecting to an optical subassembly (**16**) includes a board base (**230**), a conductive trace (**232**), and a board conductor (**234**). The optical subassembly (**16**) includes at least one component pad (**346**). The board base (**230**) is made of a substantially nonconductive material. Further, the board base (**230**) defines a recessed region (**238**) that is sized and shaped to receive a portion of the optical subassembly (**16**). The conductive trace (**232**) is secured to the board base (**230**). The board conductor (**234**) is positioned near the receiver region (**238**). Further, the board conductor (**234**) is positioned near the component pad (**346**) when the optical subassembly (**16**) is positioned in the receiver region (**238**). Moreover, the board conductor (**234**) is electrically connected to the conductive trace (**232**).

20 Claims, 5 Drawing Sheets




10
22
18
12
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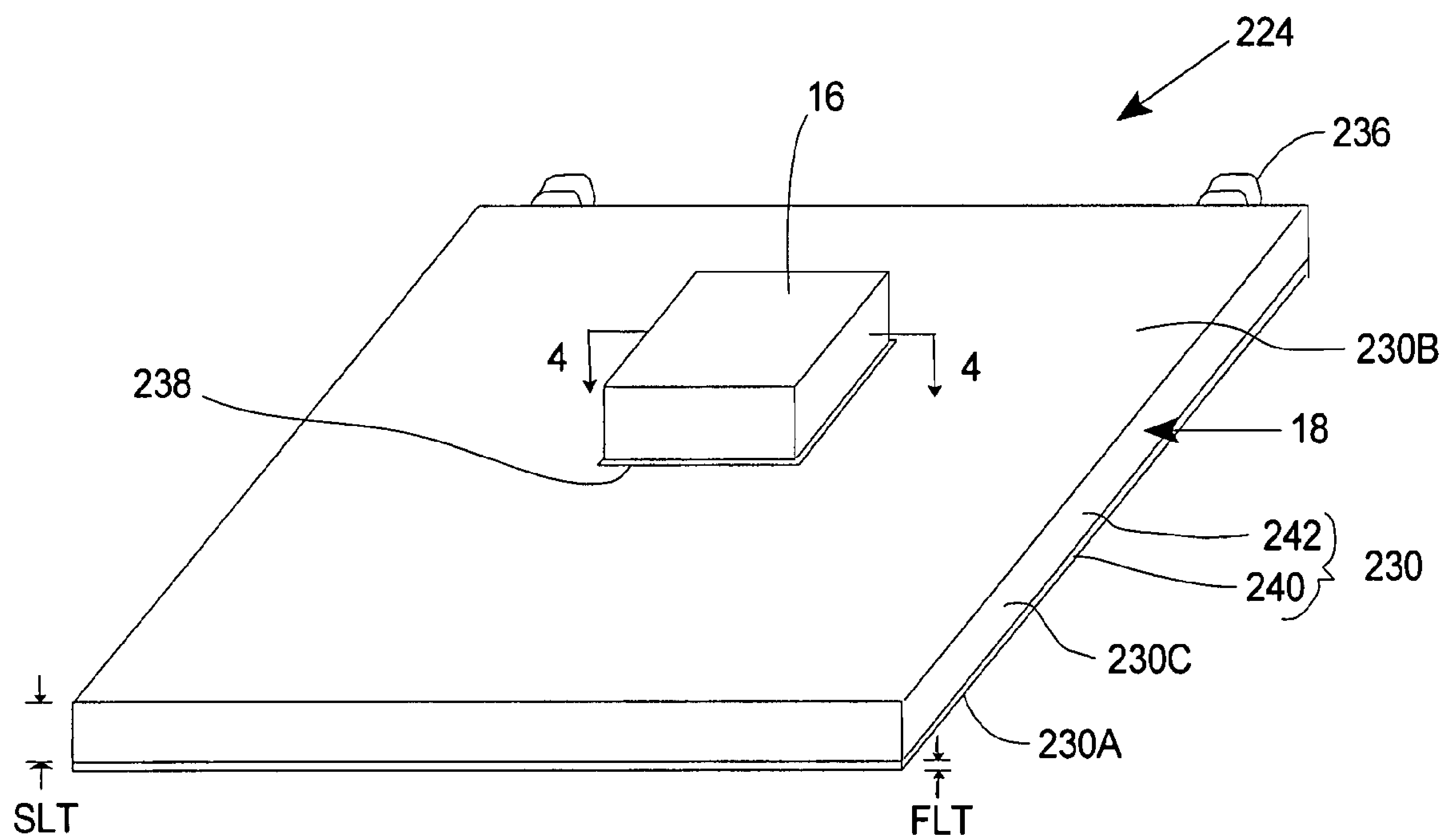
20
14

Fig. 1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236
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4
238
230B
18
242
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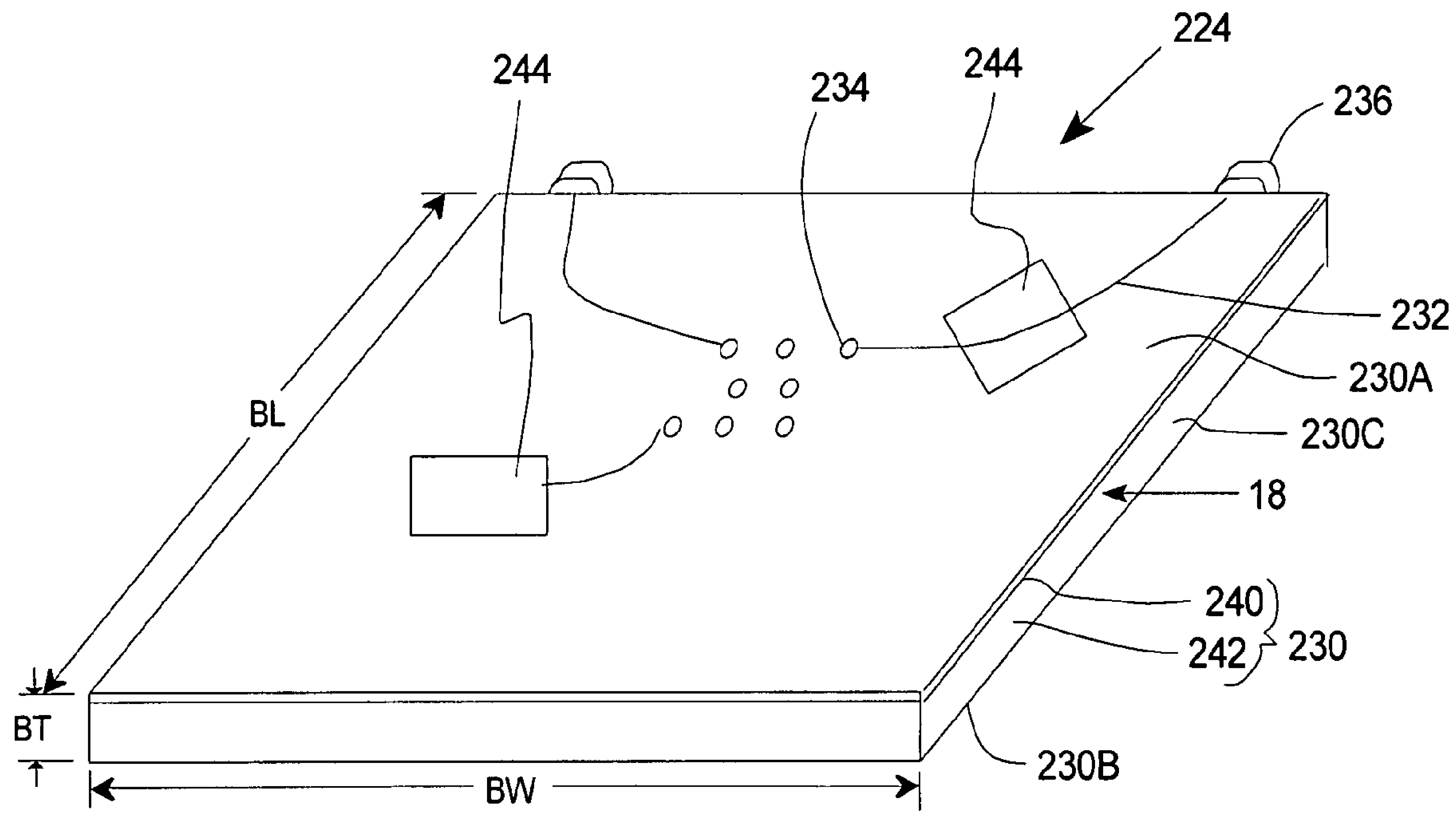
230
230C
230A
SLT
FLT

Fig. 2A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230A
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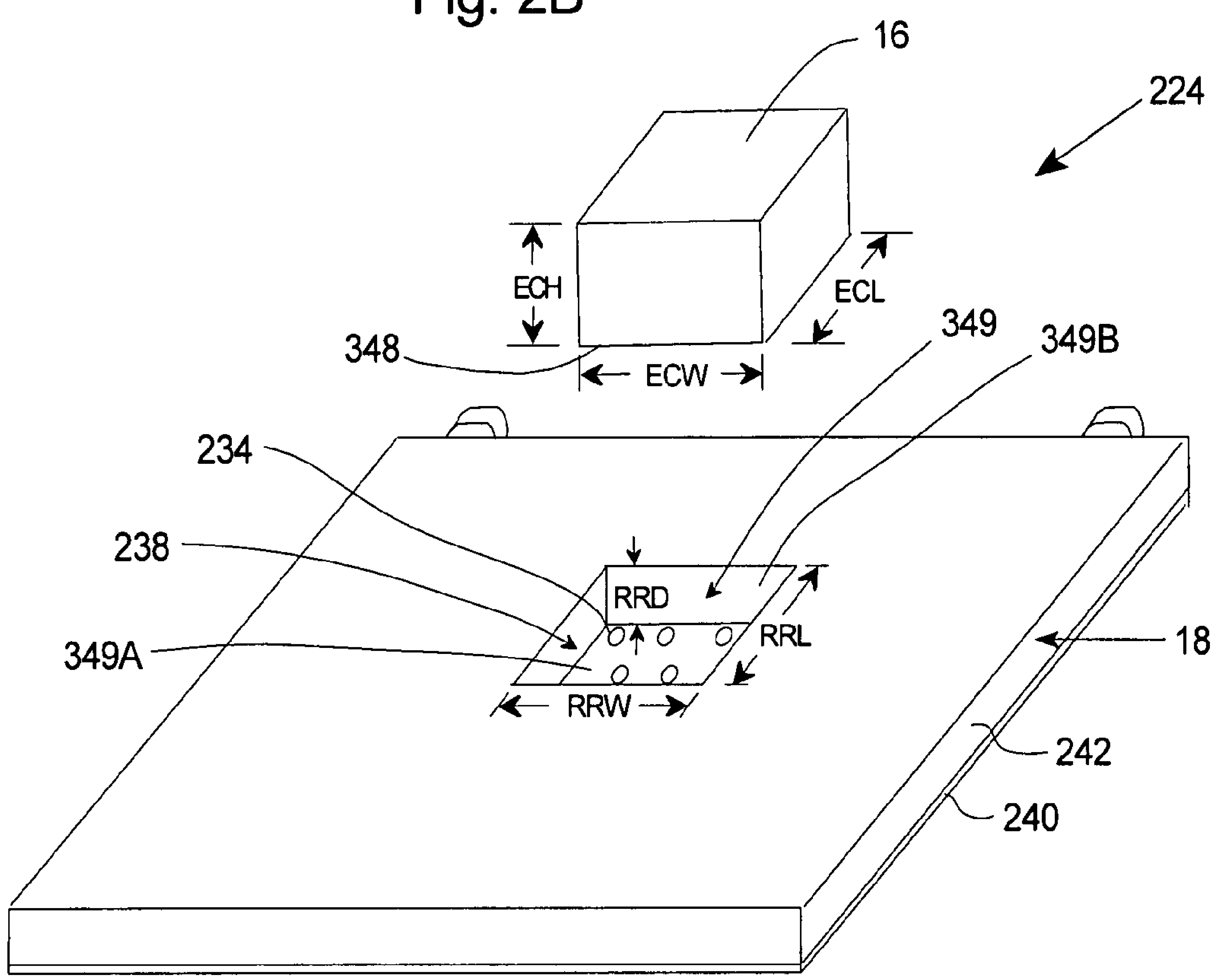
Fig. 2B


16
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349B
234
238
RRD
RRL
349A
RRW
18
242
240

Fig. 3A

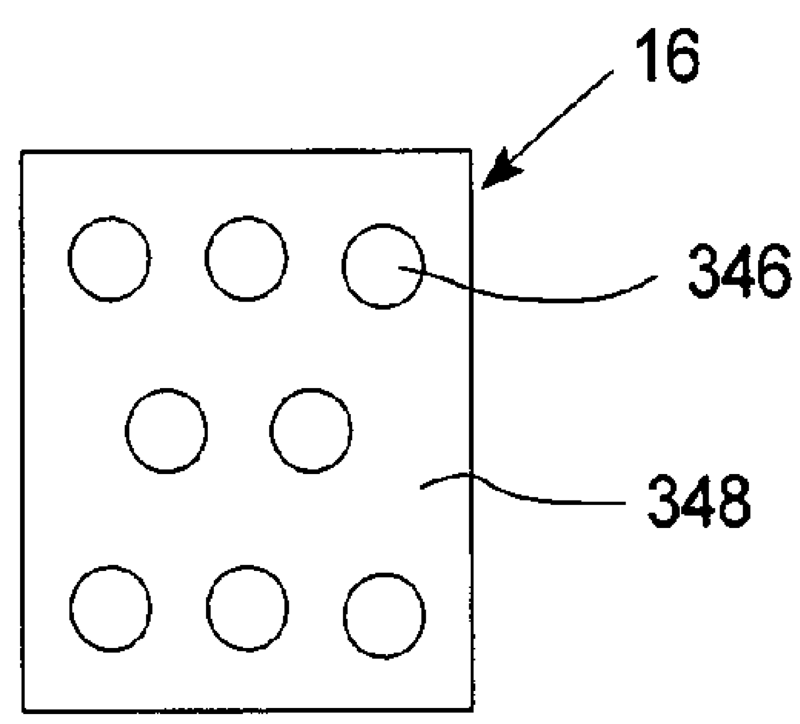

Fig. 3B

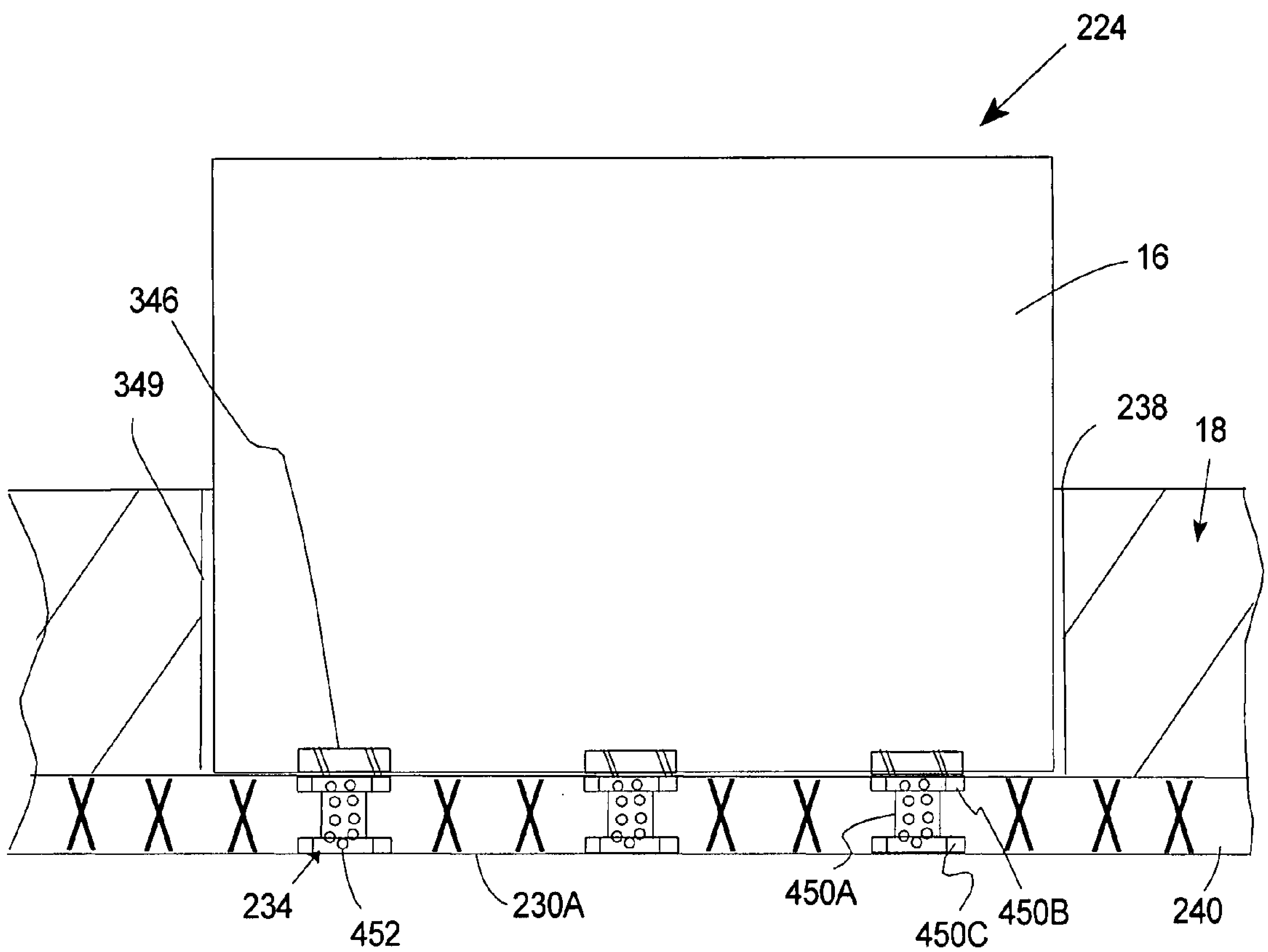

Fig. 4

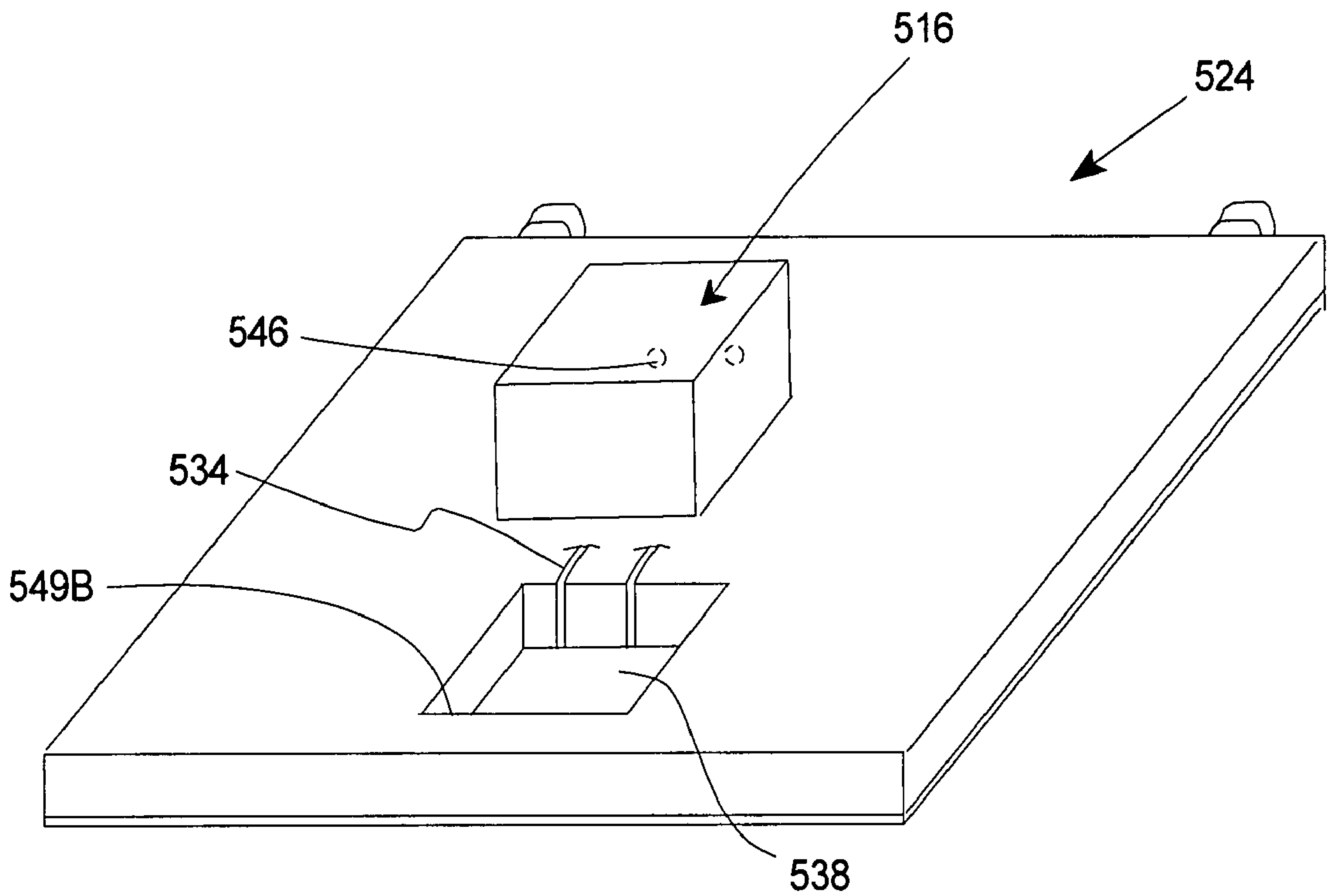

Fig. 5

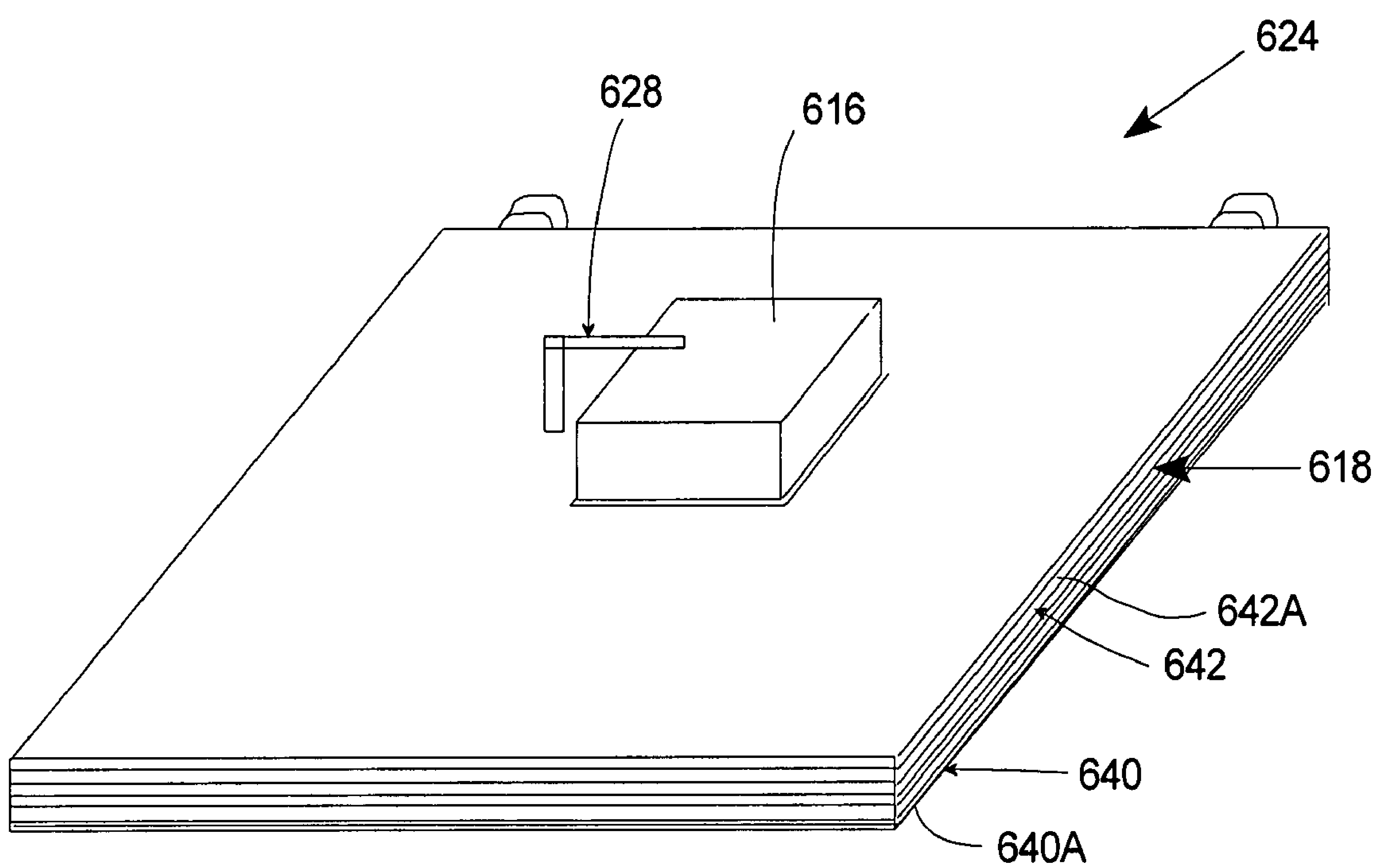

Fig. 6

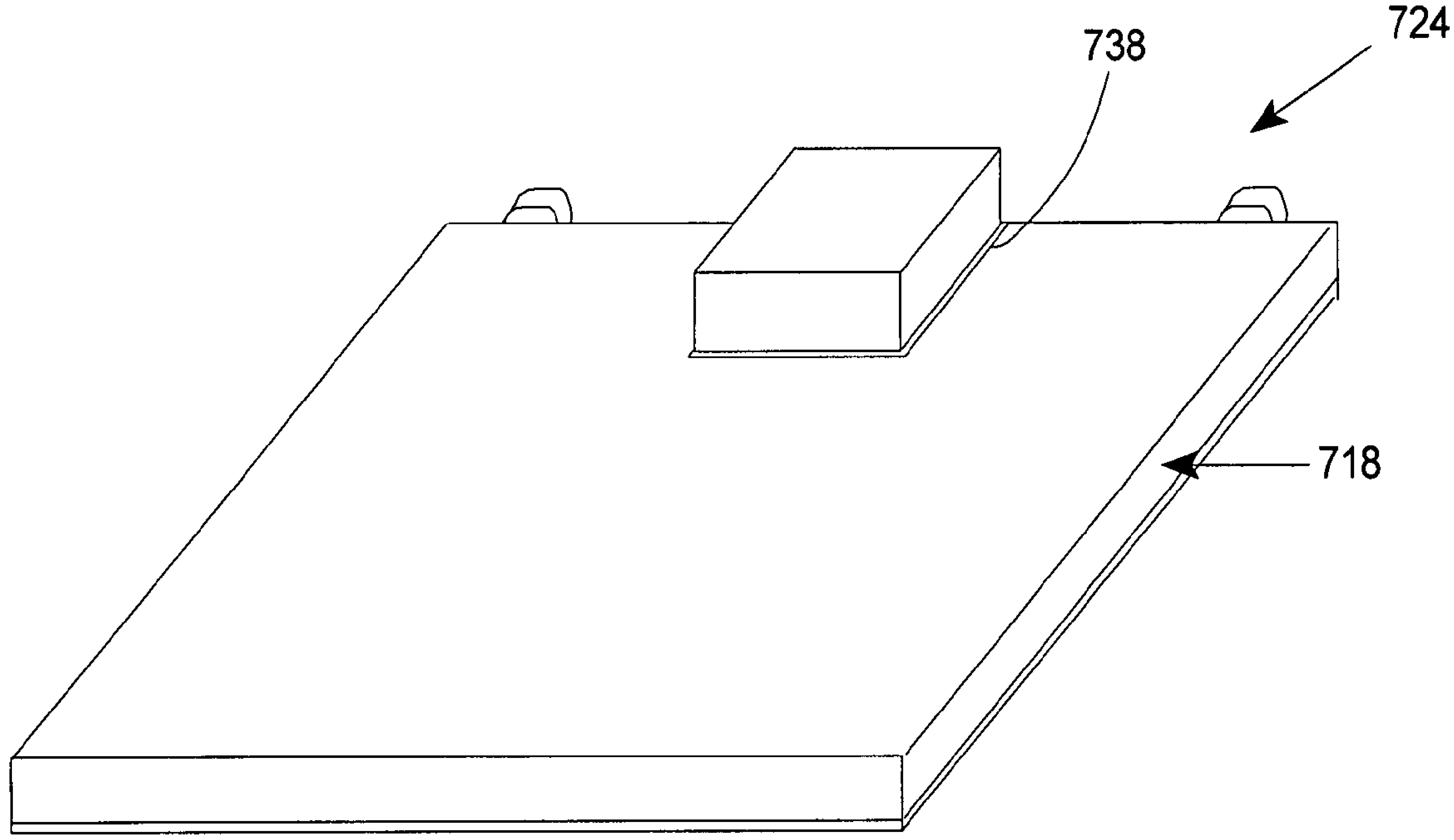

Fig. 7

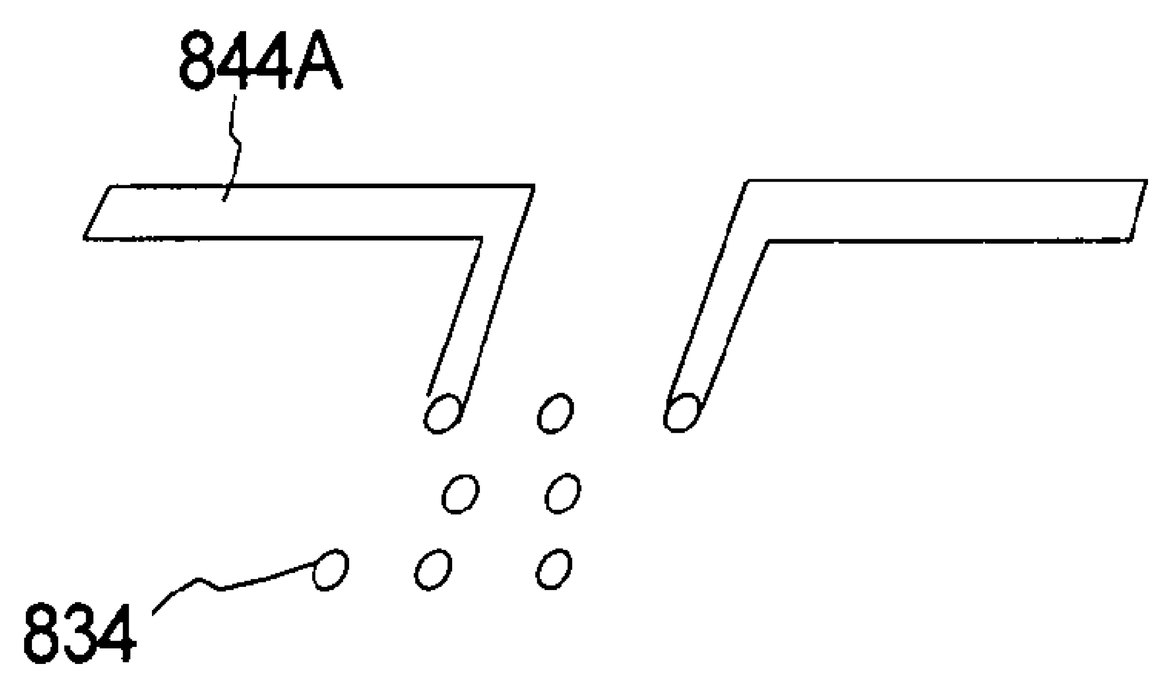

Fig. 8A

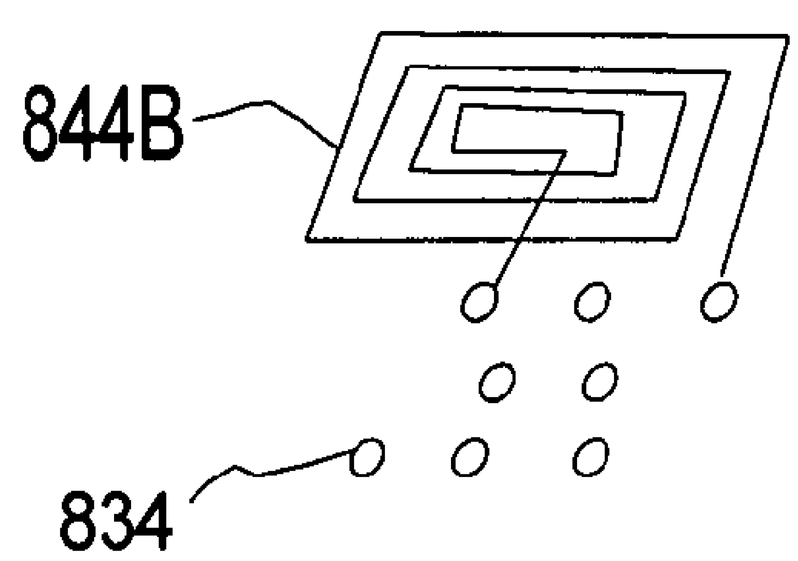

Fig. 8B

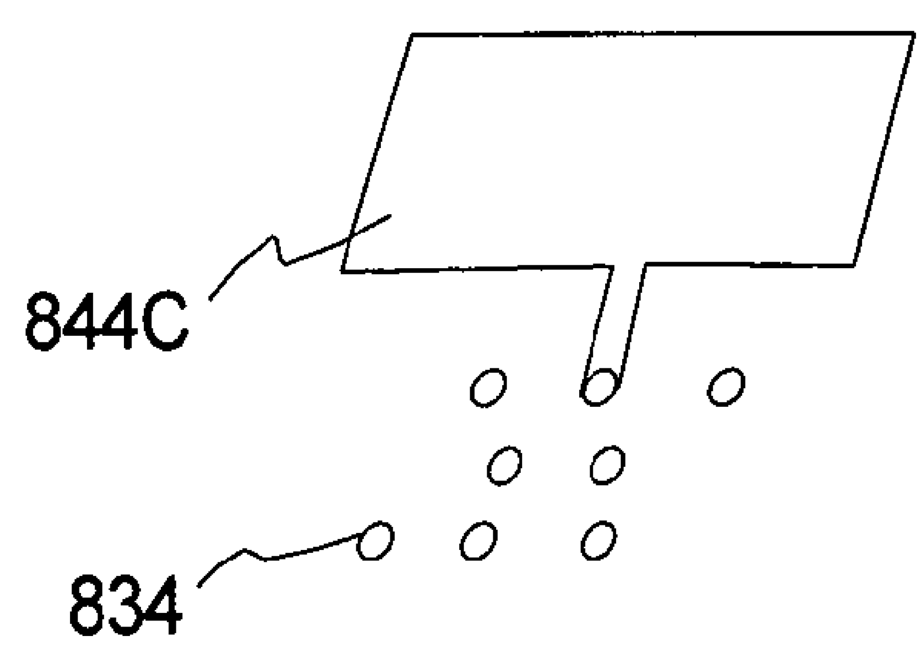

Fig. 8C

PRINTED CIRCUIT BOARD WITH RECESSED REGION

RELATED APPLICATION

This application claims priority on Provisional Application Ser. No. 60/793,479 filed on Apr. 20, 2006 and entitled "PRINTED CIRCUIT BOARD WITH RECESSED REGION". As far as is permitted, the contents of Provisional Application Ser. No. 60/793,479 are incorporated herein by reference.

BACKGROUND

Optical subassemblies such as receive optical subassemblies ("ROSA") are used to convert optical signals into electrical signals that can subsequently be analyzed. In certain designs, the ROSA is soldered to a flexible electrical circuit board that is subsequently attached to a rigid printed circuit board.

Unfortunately, the flexible circuit board does not rigidly secure the ROSA to the printed circuit board. Moreover, the soldering of the ROSA to the flexible circuit and flexible circuit to the printed circuit board can be time consuming and relatively difficult to perform. Moreover, circuit boards can be inconsistent. This can influence the performance of the optical subassembly.

SUMMARY

The present invention is directed to a printed circuit board for electrically connecting to an electrical component, such as an optical subassembly that includes at least one component pad. The printed circuit board includes a board base, a conductive trace, and a board conductor. The board base is made of a substantially nonconductive material. Further, the board base defines a recessed region that is sized and shaped to receive a portion of the electrical component. The conductive trace is secured to the board base. The board conductor is positioned near the receiver region. Further, the board conductor is positioned near the component pad when the electrical component is positioned in the recessed region. Moreover, the board conductor is electrically connected to the conductive trace.

With this design, in certain embodiments, the electrical component can be electrically and mechanically coupled to the printed circuit board in a relatively simple, secure, consistent and inexpensive fashion.

In one embodiment, the board conductor extends through the base board into the receiver region. Further, the board conductor can include a barrel and solder that electrically connects the barrel to the component pad.

In one embodiment, the board base includes a substantially nonconductive first layer and a substantially nonconductive second layer that is stacked on the first layer. In this embodiment, the recessed region is defined by an aperture that extends through the second layer. In one embodiment, the second layer is at least approximately 10 percent thicker than the first layer.

The present invention is also directed to a combination that includes an optical subassembly that is secured to the printed circuit board. In another embodiment, the present invention is directed to a precision apparatus including an analyzer and the combination. In yet another embodiment, the present invention is directed to a method for securing an electrical component to a printed circuit board.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features of this invention, as well as the invention itself, both as to its structure and its operation, will be best understood from the accompanying drawings, taken in conjunction with the accompanying description, in which similar reference characters refer to similar parts, and in which:

FIG. **1** is a simplified illustration of a precision apparatus having features of the present invention;

FIG. **2**A is a bottom perspective view of a combination having features of the present invention;

FIG. **2**B is a top perspective view of the combination of FIG. **2**A;

FIG. **3**A is a partly exploded perspective view of the combination of FIG. **2**A;

FIG. **3**B is a bottom plan view of an electrical component having features of the present invention;

FIG. **4** is a cut-away view taken on line **4-4** in FIG. **2**A;

FIG. **5** is a partly exploded perspective view of another combination having features of the present invention;

FIG. **6** is a bottom perspective view of still another combination having features of the present invention;

FIG. **7** is a bottom perspective view of yet another combination having features of the present invention; and

FIGS. **8**A-**8**C are three alternative illustrations of possible board component layouts.

DESCRIPTION

Referring initially to FIG. **1**, the present invention is directed to a precision apparatus **10** that, for example, can be used as or in telecommunication equipment, data communication equipment, technical instruments, or scientific instruments. FIG. **1** is a simplified, non-exclusive view of one embodiment of the precision apparatus **10**. In this embodiment, the precision apparatus **10** includes an optical source **12**, an analyzer **14**, an electrical component **16**, e.g. an optical subassembly, and a printed circuit board **18**. The design and orientation of the components of the precision apparatus **10** can be changed to suit the requirements of the precision apparatus **10**. Additionally, the precision apparatus **10** can include more components or fewer components than that illustrated in FIG. **1**.

As an overview, in certain embodiments, the printed circuit board **18** is uniquely designed so that the electrical component **16** can be electrically connected to and attached to the rigid printed circuit board **18** in a relatively simple and reliable fashion, and with minimal heat damage, or heat stress.

The optical source **12** generates an optical beam (not shown) that is analyzed by the rest of the precision apparatus. For example, the optical source **12** can be a laser source, or a light emitting diode ("LED"). Alternatively, the optical source **12** could be a remote instrument, such as a television remote control box. The optical source **12** could be to (not part of) the apparatus. In this case, for example, the light would shine into the end of the optical fiber **20**, or the light would shine directly into the electrical component **16**.

The analyzer **14** can be used to analyze the signal from the electrical component **16**. For example, the analyzer **14** can be an oscilloscope, a spectrum analyzer, a telecom receiver, or a pulse detector.

The electrical component **16** is mechanically fixed and electrically coupled to the printed circuit board **18**. In one embodiment, the electrical component **16** is an optical subassembly that receives the optical signal from the optical source **12** and converts the optical signal into an electrical signal for subsequent processing with the analyzer **14**. For example, the optical subassembly **16** can be a receive optical subassembly (commonly referred to as a "ROSA"). In one embodiment, the ROSA includes a photodetector that converts light to electrical current and an amplifier that amplifies the current.

In another, non-exclusive embodiment, the electrical component **16** is an electrical transmitter that sends data or a signal to another location.

The printed circuit board **18** retains the optical subassembly **16** and is used to electrically connect the optical subassembly **16** to the analyzer **14**. The printed circuit board **18** is described in more detail below.

Additionally, the precision apparatus **10** can include one or more optical fibers **20** that each carries one or more optical signals between the optical source **12** and the optical subassembly **16**, and one or more electrical lines **22** that electrically connects the printed circuit board **18** to the analyzer **14**.

Additionally, the apparatus **10** can include multiple other components that are not shown in FIG. **1**. For example, the apparatus **10** can include one or more lasers, receivers, and amplifiers that are not shown.

FIG. **2**A is a bottom perspective view and FIG. **2**B is a top perspective view of a combination **224** that includes the optical subassembly **16** and the printed circuit board **18**. In this embodiment, the optical subassembly **16** is generally rectangular box shaped and the printed circuit board **18** is rectangular plate shaped. Alternatively, one or both of these components can have another configuration.

The design of the printed circuit board **18** can vary pursuant to the teachings provided herein. In one embodiment, the printed circuit board **18** includes a board base **230**, a plurality of conductive traces **232** (only three are illustrated), a plurality of board conductors **234**, and a plurality of end launch connectors **236**.

The board base **230** is generally rectangular plate shaped, generally rigid, and is made of a substantially nonconductive material. In one embodiment, the board base **230** has a base length BL of approximately 1.8 inches, a base width BW of approximately 1.6 inches, and a base thickness BT of approximately 0.625 inches. Alternatively, board base **230** can have another shape or size. In this embodiment, the board base **230** includes a top **230**A, an opposed bottom **230**B and four sides **230**C. It should noted that the terms top **230**A and bottom **230**B are merely used for convenience of reference and that these surfaces can be switched.

In the embodiment illustrated in FIGS. **2**A and **2**B, the board base **230** includes a recessed region **238** that is sized and shaped to receive a portion of the optical subassembly **16**. Stated in another fashion, the recessed region **238** can have a size and configuration that is similar to the cross-sectional size and configuration of the optical subassembly **16**. The recessed region **238** can also be referred to as a well.

In FIGS. **2**A and **2**B, the optical subassembly **16** is generally rectangular shaped and the recessed region **238** is a generally rectangular shaped aperture that extends into a portion of the board base **230** from the bottom **230**B towards the top **230**A. Alternatively, if the optical subassembly **16** has another configuration, the recessed region **238** can have another matching configuration. In certain embodiments, because a portion of the optical subassembly **16** fits within the recessed region **234**, the sides of recessed region **234** assist in inhibiting movement of the optical subassembly **16** and the overall height of the combination **224** is reduced.

In one embodiment, the board base **230** is made of a substantially nonconductive first layer **240**, and a substantially nonconductive second layer **242** that is stacked on the first layer **240**. In this embodiment, the first layer **240** defines the top **230**A and the second layer **242** defines the bottom **230**B. Further, the recessed region **234** is defined by an aperture that extends through the second layer **242**. Moreover, the layers **240**, **242** can be secured together with an adhesive or another fashion.

In certain embodiments, the thickness of the layers **240**, **242** are different. For example, the first layer **240** can have a FL thickness FLT of approximately 0.004 inches and the second layer **242** can have a SL thickness SLT of approximately 0.056 inches. Stated in another fashion, in alternative, nonexclusive examples, the FL thickness FLT can be approximately 5, 10, 14, 15, 16 or 20 times less than the SL thickness SLT.

Further, in this embodiment, each of the layers **240**, **242** is generally rigid, and flat plate shaped, and can be made of nonconductive material, such as plastic, ceramics or fiberglass. One non-exclusive example of a suitable material is FR4, that is rigid, withstands relatively high temperatures, and is a good insulator.

It should be noted that the first layer **240** can be made of a plurality of separate first sub-layers (not shown) that are stacked together and/or the second layer **242** can be made of a plurality of separate second sub-layers (not shown) that are stacked together.

The conductive traces **232** are secured to the board base **230** and are used to electrically connect the electrical components that are secured to printed circuit board **18**. The number of conductive traces **232** will vary according to the number and type of electrical components coupled to the printed circuit board **18**. In FIG. **2**B, the printed circuit board **18** includes three conductive traces **232**. In one embodiment, each of the conductive traces **232** is a 50 ohm trace. Alternatively, the printed circuit board **18** can be made with more than three conductive traces **232** and/or one or more of the conductive traces can be another type of trace.

It should be noted that the printed circuit board is commonly designed to retain multiple additional board components **244** and the printed circuit board would include multiple additional conductive traces **232** electrically connected to the board components **244**. For example, one or more of the board components **244** can be an electronic component such as a connector, a resistor, a capacitor, an inductor, ferrite bead, ICs, or another type of electronic component. Alternatively, for example, one or more of the board components **244** can be an antenna that is used to transmit and/or receive signals. For example, the antenna can be implemented in the copper traces and/or the copper planes within the circuit board **18**. The antenna could be built directly within the circuit board **18** as illustrated in FIGS. **8**A-**8**C.

The board conductors **234** are used to electrically connect to the optical subassembly **16**. The number and design of the board conductors **234** can vary according to the design of the optical subassembly **16**. In FIG. **2**B, the printed circuit board **18** includes eight spaced apart board conductors **234**. Alternatively, for example, the printed circuit board **18** can include more than eight or less than eight spaced apart board conductors **234**. The design of board conductors **234** is discussed in more detail below.

As provided above, the printed circuit board is commonly designed to retain multiple additional electrical components (**244**) and the printed circuit board **18** would include multiple additional board conductors **234**.

The end launch connectors **236** provide a way to easily couple the electrical lines **22** (illustrated in FIG. **1**) to the printed circuit board **18**. The number and design of the end launch connectors **236** can vary according to the design of the electrical lines **22**. In FIG. **2**B, the printed circuit board **18** includes two spaced apart end launch connectors **236**. Alternatively, for example, the printed circuit board **18** can include more than two or less than two spaced apart end launch connectors **236**. In one embodiment, each of the end launch connectors **236** is an end-launch SMA type electrical connector.

It should be noted that in FIG. 2B, one conductive trace **232** electrically connects one of the board conductors **234** to one of the end launch connectors **236** and another conductive trace **232** electrically connects one of the board conductors **234** to one of the end launch connectors **236**.

FIG. **3**A is a partly exploded perspective view of the combination **224** and FIG. **3**B is a bottom view of the electrical component **16**. FIG. **3**A illustrates that the electrical component **16** is generally rectangular block shaped. In one embodiment, the electrical component **16** has a width ECW of approximately 0.15 inches, a length ECL of approximately 0.2 inches, and a height ECH of approximately 0.3 inches. However, the electrical component **16** can be another size or have another configuration.

Additionally, FIG. **3**B illustrates that the electrical component **16** includes at least one, electrically conductive, component pad **346**. In FIG. **3**B, the optical subassembly **16** includes eight spaced apart component pads **346**. Alternatively, for example, the optical subassembly **16** can include more than eight or less than eight spaced apart component pads **346**.

It should be noted that the component pads **346** are positioned on a subassembly surface **348** of the electrical component **16** that is positioned within the recessed region **238** and adjacent to first layer **240** of the printed circuit board **18** when the electrical component **16** is positioned within the recessed region **238**.

Additionally, it should be noted that in certain embodiments, the spacing and location of the component pads **346** correspond to the spacing and location of the board conductors **234**. Stated in another fashion, when the electrical component **16** is positioned within the recessed region **238**, each of the component pads **346** is positioned adjacent to a corresponding board conductor **234**.

Further, FIG. **3**A illustrates that the board conductors **234** extend through the first layer **240** into the recessed region **238**.

Additionally, FIG. **3**A illustrates that the recessed region **238** is generally rectangular box shaped. In one embodiment, the recessed region **238** had a width RRW of approximately 0.15 inches, a length RRL of approximately 0.2 inches, and a depth RRD of approximately 0.056 inches. Moreover, in this embodiment, the recessed region **238** depth RRD is almost equal to the thickness of the second layer **242**. However, the recessed region **238** can be another size or have another configuration.

Further, it should be noted that the recessed region **238** defines one or more walls **349** that inhibit the electrical component **16** from moving relative to the printed circuit board **18**. In FIG. **3**A, the recessed region **238** includes a bottom wall **349**A and four side walls **349**B.

FIG. **4** is a cut-away view taken on line **4-4** in FIG. **2**A. FIG. **4** illustrates that a portion of the electrical component **16** fits and is positioned within the recessed region **238**. With this design, the combination **224** has a lower height, approximately 0.304 inches in one embodiment.

Further, the walls **349** of the recessed region **238** inhibit movement of the optical subassembly **16** relative to the printed circuit board **18** along at least two axes and about one axis.

Additionally, FIG. **4** illustrates that the component pads **346** are positioned adjacent to the respective board conductors **234**. Further, FIG. **4** illustrates that in one embodiment, each of the board conductors **234** can include a tubular shaped, conductive barrel **450**A, a conductive, annular shaped first ring **450**B, and a conductive, annular shaped second ring **450**C. In FIG. **4**, each of the board conductors **234** extends completely through the first layer **240** into the recessed region **238**.

Additionally, each of the board conductors **234** can be fixedly and electrically connected to a corresponding component pad **346** with solder **452** (illustrated as circles). In one embodiment, after the electrical component **16** is positioned within the recessed region **238**, the solder **452** can be applied from the top **230**A into each of the board conductors **234**. As a result of this design, the electrical component **16** is electrically connected to and mechanically attached to the rigid, printed circuit board **18** in a relatively simple and reliable fashion.

FIG. **5** is a partly exploded perspective view of another combination **524** having features of the present invention that is somewhat similar to the combination **324** described above. However, in this embodiment, the component pads **546** (illustrated in phantom) of the electrical component **516** are positioned on a side of the electrical component **516**. Further, the board conductors **534** extend along a side wall **549**B of the recessed region **538**.

FIG. **6** is a bottom perspective view of still another combination **624** having features of the present invention that is somewhat similar to the combination **324** described above. However, in this embodiment, the printed circuit board **618** includes an attacher **628** that mechanically secures the electrical component **616** to the printed circuit board **618**. With this design, the component pads (not shown in FIG. **6**) of the electrical component **616** may not have to be soldered to the board conductors (not shown in FIG. **6**) of the printed circuit board **618**. For example, the attacher **628** can include a latch, a clamp, or another type of fastener that presses the electrical component **616** against the printed circuit board **618**.

It should be noted that in this embodiment, the first layer **640** can be made of a plurality of separate first sub-layers **640**A that are stacked together and the second layer **642** can be made of a plurality of separate second sub-layers **642**A that are stacked together. The number of sub-layers can vary. For each of the layers **640**, **642** can include **2**, **4**, **6**, **8**, or more sub-layers **640**A, **640**B.

FIG. **7** is a bottom perspective view of yet another combination **724** having features of the present invention that is somewhat similar to the combination **324** described above. However, in this embodiment, the recessed region **738** is positioned near the edge of the printed circuit board **718**.

FIGS. **8**A-**8**C are three alternative illustrations of possible board component layouts that can be used for the printed circuit boards described herein. More specifically, FIGS. **8**A-**8**C illustrate the board conductors **834** and three, non-exclusive different antennas **844**A, **844**B, **844**C that can be implemented on a printed circuit board. More specifically, (i) in FIG. **8**A, the antenna **844**A is a copper trace that forms a dipole type antenna, (ii) in FIG. **8**B, the antenna **844**B is a copper trace that forms a magnetic field antenna that can be used for RFID applications, and (iii) in FIG. **8**C, the antenna **844**C is a copper plate that forms an electric field antenna that can be used for RFID applications.

It should be noted that in the embodiments described herein, that either the component pads or the board conductors could be conductive "Bumps". The board conductors or the component pads can be springy, flexible conductors such as POGO pins commonly used in component test equipment.

While the particular apparatus **10** as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages herein before stated, it is to be understood that it is merely illustrative of the presently preferred embodiments of the invention and that no limitations are intended to the details of construction or design herein shown other than as described in the appended claims.

What is claimed is:

1. A printed circuit board for electrically connecting to an electrical component, the electrical component including at least one conductive component pad, the printed circuit board comprising:

a board base that is made of a substantially nonconductive material, the board base defining a recessed region that is sized and shaped to receive a portion of the electrical component;

a conductive trace that is secured to the board base; and

a board conductor secured to the board base near the recessed region, the board conductor being positioned near the component pad when the electrical component is positioned in the recessed region, the board conductor being electrically connected to the conductive trace; wherein the board conductor includes a barrel and solder that electrically and directly connects the barrel to the component pad.

2. The printed circuit board of claim **1** wherein the board conductor extends through the board base into a bottom wall of the recessed region.

3. The printed circuit board of claim **1** wherein the barrel is tubular shaped and the solder is at least partly positioned within the barrel.

4. The printed circuit board of claim **1** wherein the board base includes a substantially nonconductive first layer and a substantially nonconductive second layer that is stacked on the first layer.

5. The printed circuit board of claim **4** wherein the recessed region is defined by an aperture that extends through the second layer.

6. The printed circuit board of claim **1** wherein the board conductor extends through a side wall of the receiver region.

7. The printed circuit board of claim **1** further comprising an attacher for mechanically attaching the electronic component to the board base.

8. The printed circuit board of claim **1** wherein the recessed region defines a plurality of walls that inhibit movement of the electrical component relative to the printed circuit board along at least one axis.

9. The printed circuit board of claim **1** further comprising a board component that is electrically connected to conductive trace.

10. A combination including an optical subassembly and the printed circuit board of claim **1** retaining the optical subassembly.

11. A precision apparatus including an analyzer and the combination of claim **10**.

12. A combination for use in a precision apparatus, the combination comprising:

an optical subassembly that includes at least one conductive component pad; and

a printed circuit board that retains the optical subassembly, the printed circuit board comprising (i) a board base that is made of a substantially nonconductive material, the board base defining a recessed region that is sized and shaped to receive a portion of the optical subassembly; (ii) a conductive trace that is secured to the board base; and (iii) a board conductor positioned near the recessed region, the board conductor being positioned near the component pad when the optical subassembly is positioned in the recessed region, the board conductor being fixedly and electrically connected to the conductive trace, the board conductor extending through the board base into the recessed region; wherein the board conductor includes a barrel and solder that electrically and directly connects the barrel to the component pad.

13. The combination of claim **12** wherein the barrel is tubular shared and the solder is at least partly positioned within the barrel.

14. The combination of claim **12** wherein the board base includes a substantially nonconductive first layer and a substantially nonconductive second layer that is stacked on the first layer.

15. The combination of claim **14** wherein the recessed region is defined by an aperture that extends through the second layer.

16. The combination of claim **15** wherein the second layer is at least approximately 10 percent thicker than the first layer.

17. The combination of claim **12** wherein the recessed region defines a plurality of walls that inhibit movement of the optical subassembly relative to the printed circuit board along at least one axis.

18. A precision apparatus including an analyzer and the combination of claim **12**.

19. A method for electrically connecting an electrical component in a precision apparatus, the method comprising the steps of:

providing a printed circuit board that retains the electrical component, the printed circuit board comprising (i) a board base that is made of a substantially nonconductive material, the board base defining a recessed region that is sized and shaped to receive a portion of the electrical component; (ii) a conductive trace that is secured to the board base; and (iii) a board conductor positioned near the recessed region, the board conductor being positioned near the component pad when the electrical component is positioned in the recessed region, the board conductor including a barrel that extends through the base board into the recessed region; and

fixedly securing the barrel to a conductive component pad of the electrical component with solder.

20. The method of claim **19** wherein the step of providing a printed circuit board includes providing a board base that includes a substantially nonconductive first layer and a substantially nonconductive second layer that is stacked on the first layer, and wherein the recessed region is defined by an aperture that extends through the second layer.

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